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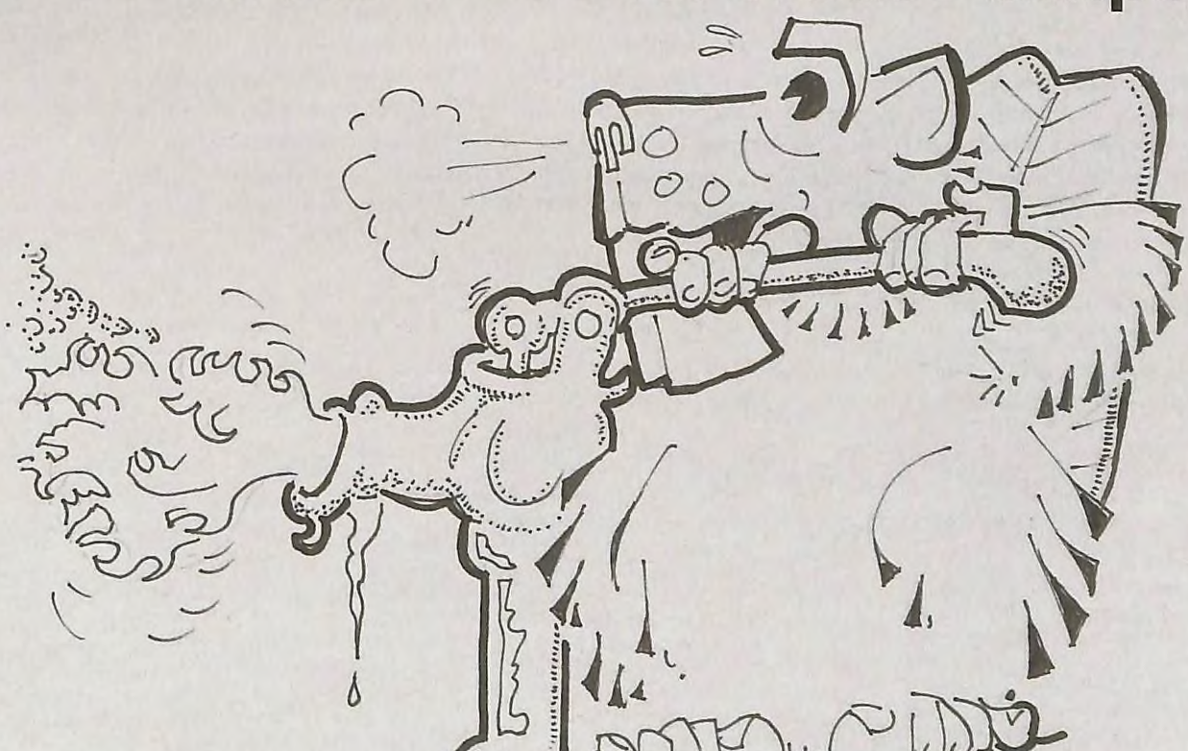
Cold Weather Heat Pumps



From the Editor . . .

I am constantly amazed how often contractors, suppliers, tradespersons and others who should know better, get bogged down by details and lose sight of the big picture. Too often everyone is working as if working to code is the absolute best standard to work to. I've even heard them discouraging an owner from doing the correct thing, or something more than the minimum in the name of 'it's all you need to meet the code'. This is especially sad to see when an owner wants to have a higher performance, more heavily insulated building.

We forget too often that the code is not the ultimate gold-plated standard to which one need to aspire to. The code and standards set out basic expectations of what should be done for a given situation, but the code at the end of the day sets out the least that can be done legally. Nothing more.

Because the code is the minimum, it may not be adequate in all instances. And if we want a good quality job to be done, it may be necessary to go beyond the code – sometimes significantly more than the minimum.

We don't seem to empower the folks in the trenches to do the right thing, even if there may be no or minimal cost implications. We seem to want to do the least that will keep us out of trouble. If it's spelled out in the code, then it must be good enough.

It happens in the regulatory field too. Every builder and designer has chafed at the seemingly ridiculous hair-splitting that takes place at times. There seems to be so little room left for reviewers to use their discretion when applying local rules and regulations. It seems they're governed by a lawyer in the back room who's checking that every 'i' and 't' be dotted and crossed in a certain way, and no other way will be accepted.

This seems to apply to initiatives that claim to promote innovation. Currently, Natural Resources Canada (NRCan) has launched an R-2000 Net-Zero Energy Pilot. It is meant to pilot the next generation R-2000 Standard and EnerGuide Rating System in net-zero energy applications, and recognize builders and homes that reach net-zero energy performance in Canada. Their call for proposals was for builder's expression of interest in participating.

The proposal call said it would consist of a simplified application with no requirement to provide detailed house designs or modelling, as it was designed to evaluate the merit of the applications. It was made clear there was no money available, but that the benefit would be to provide technical support to the builder's team to fine-tune their designs. The evaluation criteria were an assessment of the experience of the builder's team, how realistic the proposed project would be, and the replication potential. A key part of the exercise is to finalize designs to upgrade them with the best technical assistance available.

So what did the application ask for? It was what are the effective R-values of the building envelope assemblies, what type of windows are to be used, what mechanical equipment is to be used and its efficiency, and what is the estimated energy consumption of the building. Now, as any design professional will tell you, in order to be able to calculate those values, you need to have a design, with detailed information on the systems to be used. So if the information is already supposed to be available, what is it that NRCan will be providing to the team? Where is the learning opportunity? How is the innovation and exploration going to happen?

I wonder whether the origins of the exercise, which were well meaning and prepared by the technical staff, were hijacked by governmental policy types afraid of true research and innovation – something that seems to be a trait of our current regime.

Richard Kadulski
Editor

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Cold Weather Heat Pumps

A heat pump extracts heat from one place and moves it to another. Heat pump technology is not new – it has been in use for more than a century. We don't necessarily think of them as such, but refrigerators and freezers are examples of heat pumps that we rely on on a daily basis. However, when we think of heat pumps, we generally think of them as heating and cooling devices to provide space heating and/or cooling.

Heat pumps are designed to move thermal energy in the opposite direction of normal heat flow (which is from warm to cold).

The heat pump cycle is fully reversible, so that a heat pump can provide year-round climate control – heating in winter and cooling and dehumidifying in summer.

The refrigerant absorbs heat when it vaporizes, and releases it when it condenses. Because the refrigerant moves through insulated pipes between the evaporator and condenser, it allows for an efficient heat transfer over some distance. The heat source may be from the exterior air (for air source heat pumps), from the ground (for ground source or geothermal heat pumps) or from groundwater, lake, ocean or river, or a water reservoir (for water-source heat pumps).

Electricity is required to drive the pump and compressor, but it is only a fraction of the energy that will be available for conditioning the space. Typically, the heat transferred can be three or four times more than the electrical power used, giving the system a Coefficient of Performance (COP) of 3 or 4, compared to a COP of 1 for a typical electrical resistance heater, in which all heat is produced from input electrical energy. This is where the benefit of heat pumps comes in.

Air source heat pumps are the most common units used. They take heat from the outdoor air and bring it indoors. These systems have two components – one outdoors and one inside. In heating mode, the outdoor coil is an evaporator, while the indoor unit is a condenser.

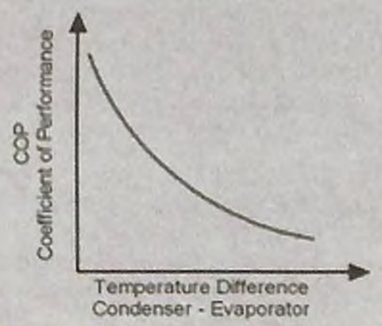
Heat pumps transfer heat by circulating a refrigerant through an evaporation and condensation cycle. The refrigerant flows through the outdoor coil (evaporator) where it absorbs heat from the air as it is evaporated. The refrigerant is then compressed at high pressure at a second coil where it condenses, at which point it releases the heat it absorbed earlier in the cycle, thus bringing the heat from the outside air indoors.

The indoor coil then transfers the heat to the indoor air, which is then circulated inside the house by an air handler as in any forced warm air system. There are also air-to-water heat pumps that transfer the heat from air to water, which is then used in hydronic heating systems or for domestic hot water use. The system can be reversed to provide cooling when it is needed. This is the typical mode for air conditioning systems.

Performance ratings

Heat pump performance ratings are calculated using a more complex formula than regular gas or oil combustion equipment. For a fuel-fired furnace or boiler, the efficiency is a simple comparison of the amount of fuel consumed and the amount of heat out, and is given as an efficiency percentage. In the case of a heat pump, performance is identified as the Coefficient of Performance (COP) which is the ratio of heat output to the amount of energy input of a heat pump.

Generally, when the outdoor air temperature increases, the temperature difference between the condenser and evaporator (i.e. between inside and outside) decreases and the COP increases. As the outdoor temperature drops, the heat pump's output falls and it becomes more reliant on the back-up heater. It's long been considered that at temperatures below freezing, there is insufficient energy in the air and the back-up heater must provide all the heat. In fact, air at -18°C contains about 85% of the heat of air at 21°C. A new generation of higher performance heat pumps, especially new cold climate equipment, operate at much lower temperatures than older equipment, so they can



- *Cold climate air source heat pumps work at cold temperatures.*
- *Cold climate air source heat pumps, with very low power draws in most conditions, are well suited to low energy homes and utility peak demand reduction programs.*
- *On average, cold climate air source heat pumps use half the energy within the home of a natural gas system.*

supply heat to a house even on cold Canadian winter days in most Canadian locations.

COP ratings are typically calculated at temperatures above freezing, so they do not reflect cold weather operation. Most of Canada has winter design temperatures that are well below -8.3°C so CSA Standards are being updated to reference lower temperature performance ratings.

The high COP of heat pumps is an important option for homes located in areas without natural gas access, where electricity or fuel oil is the primary heating fuel. In Canada about 3 million homes are electrically heated, and another million are heated with oil.

Cold climate performance

A recent study done by Natural Resources Canada looked at the performance of new cold climate air source heat pumps. New cold climate air source heat pumps (CC-ASHPs) were tested at the Canadian Centre for Housing Technology at the National Research Council in Ottawa. Ducted cold climate air source heat pumps and ductless cold climate air source heat pumps were tested and compared to standard natural gas condensing equipment.

The centrally ducted CC-ASHP had a heating COP of 1.4 to 2.4. The range varies with the temperature – it was 1.5 in the -20 to -25°C temperature range, and 2.4 at temperatures to -5°C. Compared to natural gas, the heat pump results in 49% energy savings.

The ductless cold climate "mini-split" air source heat pump was installed with 2 heads – in the master bedroom and living room. This system resulted in 60% energy savings in heating and cooling over natural gas.

The study found that overall, the new cold climate air source heat pumps do work in Canadian winters, in general using about half the energy compared to natural gas systems. At today's energy prices, cold climate heat pumps have paybacks of less than 5 years compared to fuel oil or electric baseboard heating.

Cold climate heat pumps, with very low power draws in most conditions, are particularly well suited to low energy homes such as Energy Star, R-2000, and Net Zero homes.

However, if energy use in the whole energy system is considered, the CC-ASHPs use more energy than gas in Alberta, Nova Scotia and the Northwest Territories. This is because most of the electricity in these areas is generated by oil or coal. In areas where the electrical grid has more than 20% of the electricity generated by hydro or renewables, CC-ASHPs would be more efficient than a gas furnace. ☼

Heat Pump Performance Terms

COP – Coefficient of Performance
The COP is a measure of the amount of power input compared to the amount of power output by that system. The COP is a measure of the efficiency – the higher the number, the more efficient the system is.
A heat pump that delivers 3 units of heat for every unit of energy input has a COP of 3.

EER – Energy Efficiency Ratio
The EER measures the cooling efficiency of a heat pump. The EER is the ratio of output cooling energy (in BTU) to electrical input energy (in Watt-hour). The minimum EER must be 11.5 to comply with the building code energy requirements.

SEER – Seasonal Energy Efficiency Ratio
The SEER is the ratio of output cooling energy (in BTU) to electrical input energy (in Watt-hour). SEER is a measurement of how the system behaves over a season where the outdoor temperature varies.
Because the conditions to calculate the SEER are defined in the standard, they may differ significantly from actual installations as temperatures and operating conditions vary, so it is not a predictive number, but rather a number that provides a relative efficiency value of one unit compared to another.
The new energy code provisions say that the SEER must be at least 14.5. A unit while a SEER above 20 is a very efficient system.

HSPF – Heating Seasonal Performance Factor
The Heating Seasonal Performance Factor (HSPF) is a measure of the overall heating efficiency of a heat pump during the heating season. The units are BTU/h divided by Watts. The HSPF measures the efficiency of the system in heating mode only. It applies only to heat pumps or reversible air conditioning units and not to units that only cool a space.
The minimum HSPF must be 7.1 to comply with the building code energy requirements.

Factors that affect heat pump performance

- The climate: annual heating and cooling demand and maximum peak loads;
- The temperatures of the heat source and heat distribution system;
- The auxiliary energy consumption (pumps, fans, supplementary heat system, etc.);
- The sizing of the heat pump in relation to the heat demand and the operating characteristics of the heat pump;
- The heat pump control system.

Heat Pump Installation Issues

Heat pump systems need to be designed properly. They generally require larger duct sizes than other central heating systems because when the heat pump is operating in the heating mode without supplementary heat, the air at the unit is cooler than air in a normal furnace. Furnaces generally deliver air to the living space at between 55°C and 60°C while heat pumps provide the air at about 25°C to 45°C. To deliver the same amount of heat air, they must do it in larger quantities and tend to operate for longer periods.

During defrost cycles, there is an additional drop in air temperature, and CC-ASHP Defrost Cycle Electric Resistance: Tempers the drop in supply air temperature during defrost cycles.

System design important

The temperature swing with heat pumps can be three times that of a conventional furnace. That is why a system with continuous air circulation and careful system design is important, to help maintain even conditions through the house.

Moving air will cool the skin as perspiration evaporates, which is why in summer we enjoy the moving air generated by a fan or a breeze. In the winter, we don't need cooling, so airflow can be perceived as a draft, especially with cooler air temperatures. That is why forced warm air heating systems need to be designed carefully.

A lower temperature airflow must be sized so that its velocity is slower in the occupied spaces, otherwise it will be perceived as a draft.

Many heat pump systems are sized for cooling loads, which require larger airflows. However, in the summertime where cooling is most important, feeling the airflow is not an issue. That is not the case in the heating season.

General guidelines

When installing any kind of heat pump, it is important to follow manufacturers' instructions. The following are some general guidelines to consider when installing an air-source heat pump:

- In houses with a natural gas, oil or wood furnace, the heat pump coil should be installed on the warm (downstream) side of the furnace.
- If a heat pump is added to an electric furnace, the heat pump coil can usually be placed on the cold (upstream) side of the furnace for greatest efficiency.
- The outdoor unit should be protected from high winds, which may reduce the efficiency by causing defrost problems. At the same time, it should be placed in the open so that outdoor air is not recirculated through the coil.
- To prevent snow from blocking airflow over the coil and to permit defrost water drainage, the unit should be placed on a stand that lifts the unit 30 to 60 cm (12 to 24 in.) above the ground.
- It is advisable to locate the heat pump outside the drip-line of the house to prevent ice and water from falling on it, which could reduce airflow or cause fan or motor damage.
- The pan under the inside coil must be connected to the home's interior floor drain, to ensure that the condensate that forms on the coil drains properly.
- The heat pump should be placed so that there is enough room to service the unit.
- Refrigerant lines should be as short and straight as possible. The lines should be insulated to minimize heat loss and to prevent condensation.
- Fans and compressors make noise. Locate the outdoor unit away from windows and adjacent buildings. Some units make additional noise when they vibrate. This can be reduced by selecting quiet equipment or by mounting the unit on a noise-absorbing base. Some of the new higher performance equipment is much quieter than older heat pumps. ☼

Solar Decathlon

The Solar Decathlon is a biennial competition for collegiate teams from around the world sponsored by the US Department of Energy. The object is for the teams to design, build, and operate solar-powered houses that are cost-effective, energy-efficient, and attractive. The winner of the competition is the team that best blends affordability, consumer appeal, and design excellence with optimal energy production and maximum efficiency.

The main purpose of the competition is to demonstrate to the public that net-zero, solar homes are feasible, affordable and desirable while also developing the next generation of building professionals. Since its origins in 2002, the Solar Decathlon has quickly become one of the most prestigious and publicized events of its kind.

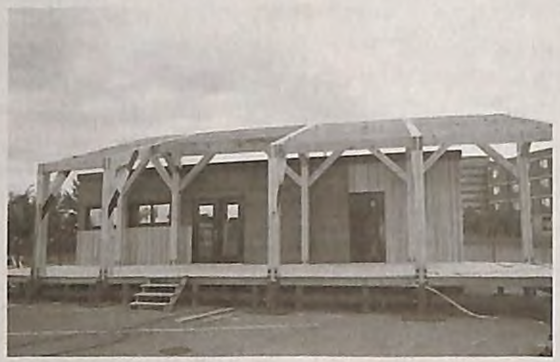
Teams are prequalified. The top 20 are selected and proceed to fine tune their design and build their house, which must then be transported to the Decathlon site where each house is then tested and rated for each of ten categories:

Architecture	Comfort Zone
Market Appeal	Hot Water
Engineering	Appliances
Communications	Home Entertainment
Affordability	Energy Balance

The competition has been held on the Mall in Washington, DC. This year the competition is moving to a new location in Irvine, California. The Solar Decathlon 2013 will take place Oct. 3–13, 2013, at the Orange County Great Park in Irvine, California. The competition houses will be open to visitors for eight days.

Among this year's 20 teams are four from outside the United States: Team Alberta, from the University of Calgary, Team Ontario (a collaboration of students and faculty from Queen's University, Carleton University, and Algonquin College), Czech Republic from the Czech Technical University, Team Austria from the Vienna University of Technology.

Information:
www.solardecathlon.gov



Team Ontario calls their house the ECHO (for Ecological Home). Their goal is to set the standard for sustainable living and create waves of change in the housing market. The ECHO home will have a grand unveiling on August 17 at the Algonquin College Woodroffe campus in Ottawa. It will be on public display August 14 to 18th.

Information:
www.ontariosd.ca

Team Alberta calls their home Borealis. It is meant to provide sustainable living and the comforts of a home for remote working populations. It is designed as modular prefabricated housing for the resource industries in western Canada, and addresses housing shortages with a sustainable alternative.

It is unique in that it encompasses two residential modules centered on a shared service core, which includes kitchen and dining, bathroom, and mechanical room, but each unit maintains individual outside access.

Information:
www.solardecathlon.ca

Net-Zero Energy Home North American Leadership Summit

The Net-Zero Energy Home (NZEH) Coalition is a not-for-profit organization that champions advanced energy efficient residential construction. Its object is to accelerate the market development of affordable net-zero energy homes.

The NZEH Coalition has embraced and actively supported CMHC's EQuilibrium™ Sustainable Housing Demonstration Initiative. EQuilibrium™ housing represents a significant step forward in reducing the energy consumption of Canada's housing sector, supporting the growing need for renewable energy solutions and helping Canada achieve a clean and healthy environment.

Following up on the EQuilibrium initiative, NRCan is now working on the R-2000 Net-Zero Energy Pilot project.

To broaden industry involvement, the NZEH Coalition will be hosting the Net-Zero North American Leadership Summit from October 8-10 in Irvine, California, in conjunction with the US Department of Energy Solar Decathlon 2013. This is the first of its kind gathering of industry leaders in the growing net-zero energy movement. Net-zero innovators will meet to share and discuss the evolving practice, model policies, finance and real estate solutions and technology gaps. The intent is to map the path to net-zero – identifying opportunities for collaboration and combining efforts across North America for greater impact.

The agenda is going to include a Builder Exchange (for the top net-zero energy builders in North America), as well as an Innovation Hall that will offer an opportunity for leading stakeholders with success stories to share information with attendees one-on-one and in small groups. In the innovation hall, attendees will be able to talk directly with project teams on net-zero energy issues with successful developments, products and experiences. ☼

For information about the Net-Zero North American Leadership Summit:
www.netzeroenergysummit.com

NZEH Coalition Webinar Series

In order to promote net-zero energy homes and disseminate best practices, the NZEH Coalition has been offering monthly informational and educational webinars. Topics in the past year have included:

- Affordable Net-Zero Energy Housing – Optimization Research
- The Path to Net-Zero Project
- Creating Net-Zero Energy Homes: Low/No-Tech Opportunities
- The Harmony House EQuilibrium NZE Project: Design, Construction and Lessons Learned
- Net-Zero in the Frozen North: Lessons Learned from 4 Generations of Net-Zero Houses
- Strategic Adaptive Philanthropy and Social Enterprise
- International Approaches to Net-Zero Energy Housing
- Housing for a Changing World
- US DOE Challenge Home: Defining Zero Net-Energy Ready Homes and Their Business Case
- Modelling Net-Zero Energy Homes with BeOPT
- Laneway Homes: The Top Ten Reasons to Build Small
- Designing with SIPS to Assure a Net-Zero-Energy Outcome
- Current National and International Research Initiatives into Near and Net-Zero Energy Buildings
- How Landmark is Using Prefabrication to Build Affordable Net-Zero Energy Homes
- The Path to Net-Zero Project

For information about the Net-Zero Energy Home Coalition:
www.netzeroenergyhome.ca

What is a Net-Zero House?

NZE: A *net-zero energy home* is one that is designed, modelled, and constructed to produce as much energy as it consumes on an annual basis.

NZE-R: A *net-zero energy ready home* is one that is designed, modelled, and constructed to produce as much energy as it consumes on an annual basis but has not yet installed the onsite renewable energy generation system(s).

Canadian Home Builders' Association

Technical Committee Research News

CHBA Builders Manual Revised

The CHBA Builders Manual has been recognized as one the key reference books on advanced residential construction in Canada. Its origin was in the early 1980s as the training manual for R-2000 builders. Over the years the manual has been updated to take into account new materials, construction technologies, and changes in the Building Code.

This document converts the knowledge gained from R-2000 builders and from research done by CMHC,NRCan and NRC into useful information for builders. It is also used as a text by students in technical colleges.

The Builders' Manual has just been revised and includes an expanded section on renewable energy and a new section on home automation. $65.00 + shipping & Tax

Copies are available from CHBA. Phone 613-230-3060 or *www.buildermanual.com*

Radon

The Building Code has identified the need to address radon in homes. It requires that the foundation be sealed from the ground, that the soil under the house be permeable, and a pipe stub be installed, labelled and capped to facilitate remediation if radon is identified to be an issue after the house has been completed, occupied and tested. Typical remediation entails depressurising the soil under the house, so that soil gases will not be drawn into the house. A small fan is installed to draw the radon from below the floor slab to vent it outside the home.

Builder liability is an issue still to be determined, because the presence of radon is highly variable – two identical houses on adjoining properties could have different indoor conditions, with one house being subject to elevated radon levels, while the other one has none. Generally, a house with a well-sealed basement and a properly designed and functioning ventilation system should not have any radon issues.

Radon levels can vary greatly over a period of 24 hours so short-term tests that last only a few days are not reliable. Testing is done by placing a radon detector in the lowest level of the house, and keeping it there for a period of 3 to 6 months. BC's Ministry of Health indicates that for meaningful results, the radon test should be done over a full year, or at a minimum six months during the heating season, as indoor radon levels are higher in the winter when windows and doors are closed. The aim is to get a long-term, average reading.

Tarion, the new home warranty provider in Ontario, has reported a number of claims for radon. In all cases so far, there was no soil gas barrier installed so the builders have been required to deal with the problem. Liabilities differ depending on time elapsed since occupancy but Tarion may be treating the presence of radon as a major defect for up to 5 years.

Lightweight Gypsum Board

The formulation of gypsum board has changed in recent years. New products that are 30% lighter than standard gypsum boards are now available. These have been designed for use in non-fire rated single-layer wall and ceiling applications in new residential construction and renovations, as well as ceilings where improved sag performance is desired.

Questions have been raised by some jurisdictions about the suitability of the new products, that the lightweight product may not have the same properties as the older, more massive traditional drywall. However, although these products are lighter, they still meet all code and standard requirements for fire resistance, thermal barrier, and impact resistance.

The lightweight design enables quicker and easier installation, reducing strain and fatigue for the installers. The ½" thick lightweight board is 30% lighter (1.2 – 1.4 psf).

They are not meant to be used in areas with exposure to sustained temperatures exceeding 125 °F (52 °C), or exposure to excessive, repetitive or continuous moisture. Maximum frame spacing is 24" o/c.

A Joint Statement by the Canadian Heating, Ventilation and Air Conditioning (HVAC) Industry

As a result of recent reports about the inadequate performance of heating and ventilation systems, the HVAC industry has issued a joint statement to point out that a properly designed and installed HVAC system is critical for home comfort and for the safety and health of occupants. Purchasers of newly built homes are entitled to enforcement of current requirements with respect to the design, installation and inspection of residential HVAC systems. Although not current practice in all locations, residential HVAC systems should be:

- ☞Designed by a professional engineer, engineering technologist or certified designer/technician, as evidenced by acceptable documentation and good practices associated with professional design services.
- ☞Installed by certified trades people as proven by acceptable licenses, insurance, certificates etc., using best practices associated with professional trade services.
- ☞Inspected by representatives having authority, who are qualified in HVAC inspections to ensure that:
  - All applicable regulations and bylaws have been met; and
  - The system conforms to the design documents used to obtain the installation permit.

The HVAC Initiative points out that:

- Formal provincial and industry-led HVAC education and certification programs exist for designers, tradespersons and inspectors;
- There are authoritative regulations, bylaws and codes affecting HVAC systems in Canada that need to be enforced; and
- There is an immediate need to elevate the design, installation and commissioning of HVAC systems across Canada beyond current minimum requirements.

Signatory members:

Canadian Institute of Plumbing and Heating (CIPH)
Canadian Oil Heat Association (COHA)
Heating, Refrigeration and Air Conditioning Institute of Canada (HRAI)
Thermal Environmental Comfort Association of British Columbia (TECA)

Victoria Home Builders Quit CHBA

CHBA Victoria has terminated its membership in CHBA National and CHBA-BC.

At their recent AGM, 30 of 43 members present (less than 25% of total Victoria membership), voted to opt out of the tri-level association, relinquishing their professional designations, the use of CHBA branding and marketing materials, education courses and all other benefits of membership in a national Canadian professional organization.

Their website says that very little will change for consumers and members. However, no public rationale has been provided for why they felt the need to go it alone.

It is hard to see how a small industry splinter group will be able to cope with the diverse range of issues facing the industry, not just at the local level but also the provincial and national level. Technical research, policy and regulatory issues can be complex – the industry needs a strong voice with depth to deal with these.

With a strong national organization the industry can draw on the depth of expertise of members from whichever part of the country they are in, to deal with the common issues. This is something that is more difficult for a small group to deal with as they will have neither the depth nor breadth of expertise to be able to deal with all issues the industry is facing.

Perhaps there is the Victoria hubris that since it's the provincial capital, on an island, removed from the mainland, they are different. (Islanders have always felt themselves to be a bit different – currently there is an initiative on Vancouver Island to separate from BC to form a separate province.). There may be the thought that it's a simple matter to walk across the street to talk to the provincial powerbrokers and bureaucrats. However, the latter have a duty and responsibility to deal with a much larger region, with varying technical, economic and climatic concerns, and so cannot just deal with one local group. ☼

You Asked Us: Stopping Rising Damp

What have you found is the best way to achieve a capillary break between the foundation footing and foundation walls? I have a builder who has encountered major moisture issues in the basement.

AS, Kitchener, ON

Evidence of ground water moisture into at unfinished basement can be seen here. This moisture movement is rising damp.

The issue of rising damp in below-grade structures is a major concern for the residential construction industry, as it can lead to mould, indoor air quality issues and structural damages. Rising damp is the wicking of water through the footing, into the concrete wall, and its evaporation inside the building.

Basements represent the major source of moisture into the house – and it is important to remember that no matter where you are, there is no such thing as dry soil. Rising damp increases the moisture load that leads to dampness and mould. Concrete can wick more than 3 lb. of water per sq.ft. per day.

Rising damp does not produce pools of water (as with liquid water entering a concrete wall), but rather a chronic musty smell, growing insidiously stronger when the footing is exposed to more moisture. The worst case of rising damp occurs when water ponding occurs at the footing level. This happens over impervious soils where the excavation is inadequately sloped, the drain tiles are not located below the bottom of the footing, and no sub-footing drainage layer was installed.

Even without water ponding, rising damp occurs when unprotected footings are exposed to damp ground. 'Hygroscopic' concrete wicks ground moisture up into the foundation concrete that is then evaporated inside the building. The best way to deal with the rising damp is not to place the footing on the ground where it can soak up water. This means that the footing should not be placed below the waterline. If it is siting directly on an impermeable layer, it will mean that the foundation will be sitting in the water at various times of the year.

Typical source of moisture: water accumulates on impermeable subsoil on which the foundation footing sits. Although most of this water should be removed by the storm drainage system, there is enough moisture that will be absorbed by the concrete. A good portion of this water will find its way into the basement by way of wicking through the concrete: aka rising damp.

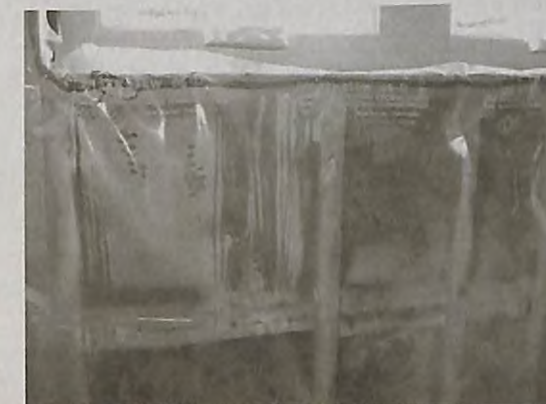
In the Vancouver area, builders often place a layer of crushed rock in the excavation before starting with the foundation in order to keep the site cleaner and usable, as otherwise in the wet coastal climate the excavation becomes a mud bowl. However, that layer of crushed rock also has the added benefit of making the whole area under the house a part of the drainage system, as it lowers the water table at the footing. This doesn't pose a structural issue in most cases - but if there is any doubt, a structural or geotechnical engineer may need to take a quick look.

In 1993, the BC Advanced House was built on a layer of crushed rock & glass – the excavation was contoured slightly so that the impermeable surface created a bowl, to channel water through the crush fill and a single storm drain was placed at a the low point of the excavation to remove the water into the municipal storm system. There have not been any issues with this approach. And of course, the walls were carefully waterproofed.

To reduce the moisture being wicked into the concrete requires proper waterproofing of the footing. When it is being built, the footing should use one of the fabric forming systems, such as the Fastfoot fabric forming (www.fastfoot.com) or with traditional form footings, make the footing waterproof by lining the form with poly.

Exterior drainage membranes are an excellent product to deflect moisture away from the foundation. However, the membrane must lap over the footing to deflect moisture away from the wall and footing – otherwise, the water will simply drain onto the top side of the footing, where it will be absorbed by the concrete.

In terms of remedial action after the fact, you need to make sure that the perimeter drainage can remove moisture. The foundation should also have a foundation drainage layer on the exterior. On the interior, a cementitious waterproofing such as Xypex or Kryton coatings on the cement will help to seal the concrete. These are crystalline chemical treatments that use water to enter the capillaries in the concrete. The moisture is used to form a new non-soluble crystalline structure that fills the capillary voids to make the concrete waterproof.



Condensation on the backside of the polyethylene vapour barrier in the basement. This is something that can often be seen during construction of new homes especially in the summer, as there is a large amount of construction moisture in the fresh concrete and framing lumber. This moisture needs to dry, and the interior is the only place it can do it. The same condition can happen when ground water is wicked up through the foundation walls – but once the basement has been finished, this is covered and is not visible. That is why ground water sources must be managed, and the basement finishes should never include impermeable materials – a 'smart vapour barrier' should always be used in the basement.

Magnesium Oxide Board: the New Wonder Material?

Magnesium Oxide (MgO) is a naturally occurring, abundant mineral. In Asia and the Middle East it has been used for centuries in mortar for masonry construction. More recently, it is being made into panels that are used for sheathing and as interior finishes, especially for partitions and fire walls.

While Magnesium Oxide board, a factory-made, non-insulating sheathing board product, was developed for the construction industry only a few decades ago, magnesium oxide itself is far from new, as it was an important material used in the Great Wall of China.

MgO board has been used in Europe and Asia as a standard panel sheathing material for years. Recently, the world's second tallest building, the Taipei 101 in Taiwan, used it for both the interior and exterior wall sheathing and subfloor sheathing.

MgO board is strong and has good flexural and tensile strength, making it suitable as a structural sheathing. It is a very resistant material that does not support mould growth, and is insect resistant. Its high fire and water resistance, and good impact resistance makes it ideal to use for damage-prone applications as well as humid coastal areas and those subject to hurricane forces.

The fire properties of MgO boards are similar to gypsum boards. It is non-combustible in terms of the building codes and has a "zero" flame spread and smoke developed rating. It does not burn at all, and can often be substituted thickness-for-thickness for Type X drywall in fire-rated wall assemblies. Some proprietary MgO systems have been tested in two-, three- and four-hour UL-rated assemblies.

Magnesium Oxide boards are now available in North America and should quickly fill a niche that will give the gypsum board manufacturers new competition, especially where fire resistive assemblies are required. In the US, MgO became UL-approved for construction in 2003.

The manufacture of MgO is considered to be environmentally superior to gypsum board because it is not as energy intensive, so has a lower embodied-energy content. In its raw form it is silvery white, and becomes a soft gray during processing. MgO is completely free of toxins, including formaldehyde, silica, asbestos, heavy metals, and organic solvents.

MgO boards come in various thicknesses, from ¼" to 1", in sheet sizes similar to those of drywall. It can be used for a number of applications including wall and ceiling linings, fascias, soffits, tile backing and underlayment.

MgO boards are harder than drywall – somewhat like the cement board used around bathtub enclosures. It is easy-to-install, similar to drywall and cement board. It can be scored and snapped, although it is stronger than drywall and requires more effort. It can be cut with a power saw, drilled-through and fastened like other similar boards. It is more flexible than Portland cement boards but less flexible than drywall, but thin sheets can be bent or warped to follow gentle curves.

MgO board can absorb water without affecting its performance, so it can be used indoors and outdoors, and in damp locations such as showers. Like cement-based siding, if MgO is used outdoors in an exposed location, it needs some form of coating. It can also be used structurally – as in bracing for walls – and also semi- structurally, such as underlayment for flooring.

One manufacturer, Magnum Building Products, has performed a variety of tests including fire, water, mould, and insect resistance to meet ASTM and UL standard compliance, so the product is code compliant.

One application where the product is being used in the US is as a facing material for structural insulated panels (SIPs). Most SIPs are made with OSB or plywood facings, but that is vulnerable to moisture and insect deterioration in the event of improper detailing, and also would have a lower fire resistance. MgO-faced SIP panels overcome this. ☼

Information:
www.magnumbp.com

Programmable thermostats

Programmable thermostats have been on the market for decades, have reached considerable technical maturity, and have been installed in most new homes. They are a low-cost investment for energy efficiency with a high potential for saving energy, as modelling shows that energy use can be reduced by about 3% for each degree of reduction in daily night-time temperature.

A typical programmable thermostat has schedules for weekdays, weekends, and vacations in addition to a hold or override option. In 1995 the EPA established an ENERGY STAR programmable thermostat program to promote these devices as a way to save energy. However, programing is not easy for most, and it's made worse by the poor design of many thermostats – buttons and type fonts that are too small, abbreviations and terminology that are hard to understand, and confusing lights and symbols, as well as illogical positioning of interface elements.

The ENERGY STAR Program is now focused on improved usability for climate control devices, on the assumption that it will facilitate energy saving behaviour.

A study by the Fraunhofer Center for Sustainable Energy Systems (CSE) looked at how people use programmable thermostats and determine whether poor design and low usability would keep people from using the thermostats to achieve energy savings. The study was done in an affordable housing complex in Massachusetts.

The project team installed non-intrusive temperature and furnace sensors and collected data from January to March 2012. Data analysis focused on four types of occupant interactions with thermostats that can lead to energy savings: nighttime setbacks, daytime setbacks, vacation holds, and reprogramming.

It was found that only 3% of households used default nighttime setbacks, regardless of the thermostat design. Although many households used the permanent hold feature, it was used to maintain a high temperature and not to keep it at a constant low level when the apartment was unoccupied. The few cases of reprogramming seemed incidental and did not involve any meaningful lowering of the temperature to save energy.

The results showed that usability did not influence the energy saving behaviour of the occupants. They found no significant difference in the temperature maintained in apartments regardless of the thermostat design. The minimum and mean nighttime and daytime setback temperature was 70°F–71°F in both thermostat conditions – much higher than the energy saving default of 62°F. Residents prefer warmer temperatures even when they are asleep – well above the currently used default settings.

The study shows that thermal comfort is much more important to people than energy efficiency. This is especially striking for affordable housing residents who pay their own heating bills. It implies that only people with a strong motivation to save energy or money (or both) can benefit from energy saving features of programmable thermostats. Most people are likely to use them to maintain a comfortable temperature in their houses.

The mere availability of energy saving features is not enough to achieve predicted energy savings. That will only happen if homeowners properly program the thermostat and select settings that will result in energy savings, such as day and night setbacks.

Further development of climate control technology is likely to improve usability and make it easier for anybody to use thermostats. However, without motivation to save energy, easy-to-use thermostats alone are not enough to facilitate the use of energy saving features in programmable thermostats.

As part of the survey, study participants were asked if they used setbacks to save money or energy. The majority of respondents agreed with both motivations. But when their behaviour was

☞People have many misconceptions about energy and thermostats.
☞Some believe that heating all the time is more efficient than turning the heat off;
☞That a thermostat is simply an on/off switch;
☞That a thermostat is a dimmer switch for heat, or some combination.

Energy savings ultimately depend on occupant behaviour and whether occupants are motivated to program their thermostats and capable of doing it when necessary.

compared to what was actually happening in their dwelling, it is evident that there is only one driving factor – thermal comfort. To achieve a comfortable temperature, the residents made regular adjustments to their thermostat settings and overrode any program that might save energy and money.

This study mirrors several other studies in the US and Canada with similar results – use of programmable thermostats doesn't realty produce the anticipated results. People who do regular setbacks do it regardless of thermostat type, whether it is programmable or manual. Residents who did not use their manual thermostat for saving energy don't start doing it when the manual thermostat is replaced with a programmable model.

If thermal comfort has a much higher priority in individual decision making than saving energy and money, the energy saving features enabled by thermostats must preserve individual comfort levels.

Although one limitation of this study is that it was done in an affordable housing project where the residents don't necessarily match the general population demographics, it was a group that one could expect to be sensitive to costs. If people with a restricted income are not interested in saving energy to save money, it is unlikely that people with an average or above average income will be compelled by financial incentives to change their heating behaviour.

Field Evaluation of Programmable Thermostats *for: US Department of Energy's Building America Program: O. Sachs, V. Tiefenbeck, C. Duvier, A. Qin, K. Cheney, C. Akers, and K. Roth, Fraunhofer Center for Sustainable Energy Systems CSE*

Coming Events:

September 25th, 2013. Vancouver, BC
2013 BC Building Envelope Council (BCBEC) Conference & AGM: *Lessons From The Past – Roadmap For The Future.* This 25th Anniversary conference will look at the evolution of building envelope technologies and advanced practices, building science fundamentals, sustainability, and processes for optimizing building performance.
Information
www.bcbec.com

September 25th, 2013. Vancouver, BC
An Evening with Joe Lstiburek An interactive session with Joe Lstiburek and leading professionals to discuss building science trends and concepts. This is a special fundraising event for the BCBEC Foundation, whose purpose is to provide scholarships for post-secondary students and apprentices who excel in the study of building envelope design, construction and technology.
Information
www.bcbec.com

Toronto, ON October 28-31, 2014
14th Canadian Conference on Building Science and Technology
Information:
http://obec.on.ca

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